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BEFORE THE ARIZONA CORPORATION COMMISSION

GARY PIERCE, CHAIRMAN
PAUL NEWMAN
SANDRA D. KENNEDY
BOB STUMP
BRENDA BURNS

IN THE MATTER OF THE APPLICATION OF ARIZONA PUBLIC SERVICE COMPANY FOR AUTHORIZATION FOR THE PURCHASE OF GENERATING ASSETS FROM SOUTHERN CALIFORNIA EDISON AND FOR AN ACCOUNTING ORDER.	Docket No. E-01345A-10-0474 **NOTICE OF FILING TESTIMONY OF WESTERN RESOURCE ADVOCATES**

Western Resource Advocates ("WRA"), through its undersigned counsel, hereby provides notice that it has this day filed the written direct testimony of David Berry in connection with the above-captioned matter.

DATED this 31st day of May, 2011.

ARIZONA CENTER FOR LAW IN
THE PUBLIC INTEREST

By_____
Timothy M. Hogan
202 E. McDowell Rd., Suite 153
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Attorneys for Western Resource Advocates

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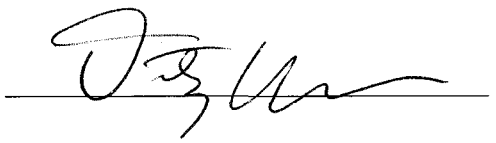
the foregoing filed this 31st day
of May, 2011, with:

Docketing Supervisor
Docket Control
Arizona Corporation Commission
1200 W. Washington
Phoenix, AZ 85007

COPIES of the foregoing
Electronically mailed this
31st day of May, 2011 to:

All Parties of Record



BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

GARY PIERCE, *Chairman*
BOB STUMP
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Testimony of

David Berry

Western Resource Advocates

May 31, 2011

Testimony of David Berry
Docket No. E-01345A-10-0474

Contents

List of Exhibits

Exhibit DB-1: Qualifications of David Berry

Exhibit DB-2: Regional Environmental Impact of APS Plan

Exhibit DB-3: Reference Scenario Cost Analysis

Exhibit DB-4: Effect of CO_2 Regulation Compliance Cost

Exhibit DB-5: Illustrative Clean Energy Portfolio to Replace Cholla Unit 1

Introduction

Q. Please state your name and business address.

A. My name is David Berry. My business address is P.O. Box 1064, Scottsdale, Arizona 85252-1064.

Q. By whom are you employed and in what capacity?

A. I am Chief of Policy Analysis for Western Resource Advocates (WRA).

Q. Please describe Western Resource Advocates.

A. Founded in 1989, Western Resource Advocates is a non-profit environmental law and policy organization dedicated to restoring and protecting the natural environment of the Interior American West. We have developed strategic programs in three areas: water, energy, and lands. We meet our goals in collaboration with other environmental and community groups and by developing solutions that are appropriate to the environmental, economic and cultural framework of the region. Western Resource Advocates has been involved in Arizona utility regulatory issues for about 20 years.

Q. What are your professional qualifications for presenting testimony in this docket?

A. Exhibit DB-1 summarizes my qualifications.

Q. What is the purpose of your testimony?

A. My testimony examines the economic and environmental benefits resulting from Arizona Public Service Company's (APS') proposed retirement of Four Corners Units 1-3 and acquisition of Southern California Edison's (SCE's) share of Four Corners Units 4 and 5. My testimony also addresses the requirement, under Decision No. 67744, that APS obtain authorization from the Commission to acquire a generating unit with an in-service date prior to January 1, 2015 as a "self-build" resource. I recommend that the Commission approve the retirement of Four Corners Units 1-3 and APS' acquisition of SCE's share of Units 4 and 5 because of the environmental and economic benefits of doing so. In addition, I provide recommendations regarding the management of the economic and environmental risks of coal-fired power generation going forward.

Summary of APS' Request

Q. What does APS propose to do at the Four Corners power plant?

A. APS currently owns 100% of Four Corners Units 1, 2, and 3 (560 MW) plus a 230 MW share of Units 4 and 5. APS proposes to acquire SCE's 723 MW share of Four Corners Units 4 and 5 for $294 million, adjusted up or down depending on whether the transfer of assets to APS occurs before or after October 1, 2012. APS has also proposed adding selective catalytic reduction (SCR) equipment to Units 4 and 5 in 2018 to reduce nitrogen oxide (NOx) emissions. The Environmental Protection Agency's (EPA's) supplemental notice of proposed rulemaking indicates that the NOx emission limit on Units 4 and 5 would be 0.098 pounds per MMBtu by July 31, 2018,[1] although this limit may be modified in a final rule.

APS will also retire Four Corners Units 1, 2, and 3 in 2012 (or possibly as late as 2014).[2] These units were built in 1963 and 1964, are relatively inefficient, and emit large quantities of sulfur dioxide, nitrogen oxides, carbon dioxide, and mercury.

Q. What has APS requested of the Commission?

A. APS has requested that the Commission authorize the acquisition of SCE's share of Four Corners Units 4 and 5. APS has also requested that the Commission issue an order that permits APS to defer, for future recovery, costs related to the acquisition of Units 4 and 5 and that allows APS to recover costs associated with Units 1-3.

Q. Does APS require the authorization of the Commission to pursue a "self-build" option having an in-service date prior to January 1, 2015?

A. Yes, according to Decision No. 67744 (page 25 and page 16 of the Settlement Agreement).

[1] Letter from Edward Fox (APS) to Jared Blumenfeld (EPA Region IX), dated November 24, 2010. Environmental Protection Agency, Supplemental Proposed Rule of Source Specific Federal Implementation Plan for Implementing Best Available Retrofit Technology for Four Corners Power Plant: Navajo Nation, 76 *Federal Register* (February 25, 2011) 10530.

[2] APS' 2009 resource plan does not show the retirement of any existing generation through 2025.

Environmental Benefits of Retiring Four Corners Units 1-3

Q. What is the impact of APS' proposal with respect to air emissions and water consumption?

A. **As a result of retiring Four Corners Units 1-3, SCE's deployment of cleaner resources, and installing emission controls on Four Corners Units 4 and 5, air emissions and water consumption decline dramatically, indicating an improvement in environmental conditions relative to 2009.**

Exhibit DB-2 summarizes the regional environmental impacts using publicly available data from APS' FERC Form 1, the Environmental Protection Agency, the Energy Information Administration, and other public sources. The baseline is operation of the entire Four Corners power plant in 2009. We do not know how SCE will replace the energy and capacity generated by its share of Four Corners Units 4 and 5, so I analyzed two "bookend" strategies. The top panel of the exhibit assumes SCE replaces its share of Four Corners 4 and 5 with gas generation and the bottom panel assumes SCE replaces its share of Four Corners 4 and 5 with renewable energy (such as a portfolio of photovoltaics, wind, and geothermal resources in which the geothermal plant uses dry cooling).[3]

Relative to 2009 operation of the Four Corners Power Plant, carbon dioxide emissions would decline by between 19% and 34%, sulfur dioxide emissions would decline by about 25%, nitrogen oxide emissions would decline by about 88%, mercury emissions would decline by at least 61%, and water consumption would decline by between 18% and 30%.

The level of NOx emissions reductions due to add-on post-combustion NOx controls for Units 4 and 5 is assumed to be the level set forth in EPA's Supplemental Notice dated February 25, 2011. EPA's proposal is predicated on APS shutting down Four Corners Units 1-3 by January 1, 2014 and a NOx emissions limit of 0.098 pounds per MMBtu for Units 4 and 5 by July 31, 2018. EPA may adopt a more stringent limit on NOx emissions.

Q. Please describe the lay-out of Exhibit DB-2.

A. Exhibit DB-2 presents the following factors:

[3] "SCE would have replacement power from surplus existing resources in the near term and over time from an already expected, larger mix of additional renewable resources and gas-fired resources, all of which would be subject to permitting and would have to be compliant with SB 1368. SCE has no plans or need for any new power projects to come online specifically in replacement of its Four Corners Power Plant capacity," Cardno Entrix, *Proponent's Environmental Assessment: Sale of Southern California Edison Company's Interest in the Four Corners Power Plant Units 4 and 5*, November 2010, p. 3-1, California Public Utility Commission Application 10-11-010, November 15, 2010.

- A baseline level of plant operations, emissions, and water consumption (operating the entire Four Corners plant as it actually was in 2009).
- The effect of retiring Four Corners Units 1-3.
- The effect of APS acquiring SCE's 48% share of Four Corners Units 4 and 5 on the operation of APS' system – it is assumed that, with the acquisition of Units 4 and 5, APS will reduce the output of some of its gas-fired generation because the 48% share of the generation at Units 4 and 5 is greater than the output of Units 1-3.
- The effect of SCE replacing the generation from its share of Four Corners 4 and 5. SCE's replacement power is assumed to be either gas generation or renewable energy.
- The reduction in NOx emissions from Four Corners 4 and 5 as SCR is installed to meet EPA's best available retrofit technology (BART) requirements.[4] EPA may ultimately adopt a more stringent limit on NOx emissions, resulting in even lower emissions than shown in Exhibit DB-2.

Q. Why are reductions in air emissions beneficial?

A. Reducing SO_2 and NOx emissions from Four Corners will reduce health and other impacts of power generation on people living in the Southwest. Sulfur dioxide and nitrogen oxides contribute to acid rain and react in the atmosphere to produce fine particulate matter. The fine particulate matter is associated with several types of health impacts, including premature mortality, bronchitis, hospital admissions, asthma, and heart attacks.[5] SO_2, NOx and particulate emissions also impair visibility in and near national parks by either directly scattering light or by forming compounds in the atmosphere that scatter light. Reducing these emissions will improve visibility.

Reducing mercury emissions from coal-fired power plants will also benefit public health and wildlife. The Environmental Protection Agency indicates that mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Additionally, high levels of methylmercury in the bloodstream of unborn babies and young children may harm the developing nervous system. EPA also states that "Birds and

[4] EPA, Supplemental Notice of Source Specific Federal Implementation Plan for Implementing Best Available Retrofit Technology for Four Corners Power Plant: Navajo Nation, 76 *Federal Register* 10530 (February 25, 2011).

[5] C. Arden Pope III, Majid Ezzati, and Douglas Dockery, "Fine-Particulate Air Pollution and Life Expectancy in the United States," New *England Journal of Medicine*, 360 (January 22, 2009): 376-386. Clean Air Task Force, *The Toll from Coal*, Boston, MA: September 2010. Abt Associates, *Technical Support Document for the Powerplant Impact Estimator Software Tool*, July 2010, available at http://www.catf.us/resources/publications/files/Abt-Technical_Support_Document_for_the_Powerplant_Impact_Estimator_Software_Tool.pdf. Jonathan Levy, Lisa Baxter, and Joel Schwartz, "Uncertainty and Variability in Health-Related Damages from Coal-Fired Power Plants in the United States," *Risk Analysis* 29 (2009): 1000-1014. Clean Air Task Force, "Death and Disease from Power Plants," interactive map, http://www.catf.us/coal/problems/power_plants/existing/. National Research Council, *The Hidden Cost of Energy*, Washington, D.C.: National Academies Press, 2010.

mammals that eat fish are more exposed to mercury than other animals in water ecosystems. Similarly, predators that eat fish-eating animals may be highly exposed. At high levels of exposure, methylmercury's harmful effects on these animals include death, reduced reproduction, slower growth and development, and abnormal behavior."[6]

CO_2 emissions contribute to long term climate change that results in changed precipitation patterns, higher temperatures in many regions, and a rise in sea level.[7] Reducing CO_2 emissions will help avoid increased concentrations of greenhouse gases in the atmosphere over the long run, which will in turn reduce the adverse impacts of climate change.

Costs

Q. Did you analyze the lifecycle costs of APS' proposal?

A. Yes. I prepared a reference scenario and then modified some assumptions as explained below. In particular, I compared the incremental cost to APS of its proposal in this docket and several other options. I used APS' responses to our data requests and other publicly available data, including APS' and other utilities' 2009 FERC Form 1, the APS-SCE purchase and sale agreement, SCE's filings on the transaction at the California Public Utilities Commission, data from the Energy Information Administration, studies prepared by the Department of Energy's National Energy Technology Laboratory, and EPA's proposed rules pertaining to impairment of visibility caused by the Four Corners power plant, coal combustion residuals, and mercury emissions. More detail can be found in Exhibit DB-3.

Exhibit DB-3 compares the present values of APS' incremental cost streams through 2037 for the reference scenario for several options:

Option 1. APS continues to operate Four Corners Units 1-3 through 2037 with pollution controls to reduce NOx, mercury, and particulate emissions and continues to collect and dispose of byproducts. APS would not acquire SCE's share of Units 4 and 5 but would retain its current ownership share of those two units.

Option 2. This option represents what APS may be able to obtain by seeking competitive bids from power producers using gas-fired generation to replace Four Corners Units 1-3. APS retires Four Corners Units 1-3 at the end of 2016

[6] US Environmental Protection Agency, Mercury: Basic Information, www.epa.gov/mercury/about.htm.

[7] See for example: Susan Solomon, et al., "Irreversible Climate Change Due to Carbon Dioxide Emissions," *Proceedings of the National Academy of Sciences* 106 (February 10, 2009), 1704-1709. Richard Seager et al., "Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America," *Science* 316 (May 25, 2007), 1181-1184. Gian-Reto Walther, et al., "Ecological Responses to Recent Climate Change," *Nature* 416 (March 28, 2002): 389-395. Jonathan Overpeck and Jeremy Weiss, "Projections of Future Sea Level Becoming More Dire," *Proceedings of the National Academy of Sciences* 106 (December 22, 2009): 21461-21462.

and replaces the foregone generation with purchases of energy and capacity from gas-fired combined cycle power plants owned by other suppliers starting in 2017. APS would not acquire SCE's share of Units 4 and 5 but would retain its current ownership share of those two units.

Option 3. This option represents APS' proposed plan. APS retires Four Corner Units 1-3 in 2012 and acquires SCE's share of Units 4 and 5. APS will incur NOx and mercury pollution control costs, mine reclamation and decommissioning costs, and byproduct operating and maintenance costs associated with what was formerly SCE's share of Units 4 and 5.

Option 4. This option is illustrative of a clean energy option. APS retires Four Corners Units 1-3 at the end of 2015 and replaces the foregone generation with a portfolio of renewable energy and natural gas fired generation that produces at least as much energy and capacity as Four Corners 1-3, starting in 2016. APS would not acquire SCE's share of Units 4 and 5 but would retain its current ownership share of those two units.

In preparing the reference scenario cost estimates, I assumed no carbon dioxide emission regulation. The effect of changing this assumption is discussed below.

As indicated in Exhibit DB-3, under the reference scenario, APS' plan is the least costly of the four options considered.

Q. Could Option 2 (replacing Four Corners Units 1-3 with gas generation) provide baseload service?

A. Based on experience elsewhere, gas generation could likely provide capacity and energy equivalent to the output of Four Corners Units 1-3. In 2009, combined cycle units in Nevada and Florida operated at a capacity factor of 50% or more with heat rates around 7600 Btu/kWh or better.[8] Some of these plants achieved capacity factors over 60%. Also, my analysis does not assume that the gas option would be met by a single power plant – I assumed only that APS would purchase capacity and energy from gas-fired resources.

Q. Could Option 4 (the illustrative clean energy option) provide baseload service?

A. Yes. This illustrative portfolio includes both renewable energy and natural gas-fired generation. The details of the assumed mix of resources can be found in Exhibit DB-3. This portfolio is intended to produce at least as much capacity credit and energy as Four Corners Units 1-3.

[8] Florida Power and Light and Nevada Power Company FERC Form 1, 2009.

Q. Could APS develop a different mix of clean energy resources than that used in your illustrative portfolio?

A. Yes. There are many possible combinations of renewable resources and gas-fired generation that could replace the capacity and energy of Four Corners Units 1-3.

Q. Did you conduct any sensitivity analyses?

A. Yes. Several important factors are uncertain so I modified the reference scenario by varying some of the parameters, assuming that the other parameters would remain as presented in Exhibit DB-3. Listed below are some of the findings:

- Changing the real discount rate from 7% to 2% or 10% still results in APS' plan costing less than the other options.
- Assuming that carbon dioxide emission regulation compliance costs are $15 per metric ton (instead of $0) starting in 2015 and escalating at a real rate of 5% per year, APS' plan would cost less than the other options. However, at a cost above about $27 per metric ton of carbon dioxide emissions starting in 2015 and escalating at a real rate of 5% per year, both the gas generation resource and the clean energy portfolio would be less costly than APS' plan. Exhibit DB-4 shows the present value of APS' costs assuming CO_2 regulation compliance costs are $35 per metric ton, starting in 2015, escalating at a real rate of 5% per year; option 4 (the clean energy option) would have the lowest cost.
- Changing the assumed real coal price escalation rate from 0.56% per year (the average annual real escalation rate in New Mexico over the period 1996-2010) to 1.94% per year (the average annual real escalation rate in the US over the period 1996 to 2010) results in APS' plan still costing less than the other options. Coal prices would have to escalate by a real rate of at least 5.75% per year before the gas generation option (option 2) would be less costly than APS' plan, and by a real rate of at least 6.75% per year before the clean energy option (option 4) would be less costly than APS' plan.
- If the price of natural gas were very low – for example, $3.14 per MMBtu in every year throughout the study period (in 2010 dollars) -- starting in 2012, then the gas generation option would be less costly than APS' plan. During the 15 year period from 1996 through 2010, the annual cost of natural gas (in constant 2010 dollars) paid by the electric power industry nationally was this low in only one year.

Q. Would APS be exposed to any other environmental regulatory costs which you have not included in your analysis?

A. Yes, that is possible. In responses to WRA data requests (WRA 16, 17 and 18), APS indicated that it may have to comply with pending regulations on cooling water intake structures (76 *Federal Register* 22174, April 20, 2011) and ozone (75 *Federal Register* 2938, January 19, 2010), but that the compliance costs are currently unknown. APS also indicated that it had

not identified any other proposed or pending environmental regulations whose annual operating costs would exceed $1 million or whose capital costs would exceed $10 million.

Q. What general conclusions do you draw about the relative costs of the options?

A. I conclude that APS' plan is the least costly option under a range of reasonable assumptions. However, APS' plan does expose APS to some potentially significant risks. For example, if the costs of complying with future carbon dioxide emission regulations are moderate or high, then a clean energy portfolio may be the least cost option. Additionally, there may be other environmental regulations which impose costs on APS. I discuss risks and risk management in subsequent sections of my testimony.

Application of Decision No. 67744 and the Resource Planning Rules

Q. What does Decision 67744 require of APS?

A. Section IX of the settlement agreement contained in Decision 67744 and page 25 of the Decision indicate that APS will not pursue any self-build option having an in-service date prior to January 1, 2015 unless expressly authorized by the Commission. APS must address several factors in requesting this authorization:

a. APS' unmet needs for additional long-term resources
b. APS' efforts to secure adequate and reasonably-priced long term resources from the competitive wholesale market
c. Reasons why APS believes such efforts have been unsuccessful.
d. Consistency with APS' resource plan
e. Life-cycle costs

Q. What does WRA's analysis indicate regarding these factors?

A. Based on the environmental and cost analyses described above, WRA concludes that:

- APS' retirement of Four Corners Units 1-3 will result in major environmental improvements.
- APS will need additional long-term resources as it retires Four Corners Units 1-3.
- SCE intends to terminate its participation in Units 4 and 5 prior to July 2016 when the current Four Corners operating agreement terminates. SCE is prohibited from making life-extending financial commitments to coal-fired power plants under California's Emissions Performance Standard.

- Under these circumstances, APS was presented with an opportunity to retire Units 1-3 and replace them with SCE's share of Units 4 and 5.
- Alternative resources could be obtained from the competitive market. Our analysis, summarized above, indicates that the life cycle cost of these alternatives would be greater than the cost of APS' proposal under a range of assumptions, but not in all reasonable cases. The time needed to acquire these resources could delay the retirement of Units 1-3, however.
- With regard to resource planning, the acquisition of SCE's share of Units 4 and 5 essentially replaces the energy and capacity that would have been provided by Four Corners Units 1-3.

WRA is not able to comment on items b and c in the list of factors, above.

Q. Has the Commission provided any other direction on procurement of resources?

A. Yes. The resource planning rules indicate that a load-serving entity may acquire energy and capacity through bilateral contracts with non-affiliated entities (R14-2-705(A)(4)) and that a load-serving entity must use an RFP (request for proposal) process unless, among other reasons, the transaction presents a genuine, unanticipated opportunity to acquire a power supply resource at a clear and significant discount and provide unique value to the entity's customers (R14-2-705(B)(5)).

Q. What are your conclusions regarding the proposed transaction relative to the Commission's directives on procurement of new resources?

A. The withdrawal of SCE from Four Corners presents an unexpected and valuable opportunity for APS to retire significant amounts of old coal-fired generation, reduce costs, and improve environmental quality through a bilateral contract.

Risk

Q. Does reliance on coal-fired power generation expose APS to significant risk?

A. Yes. There are numerous cost risks of coal-fired generation. These include the possibility that coal prices could escalate more quickly than projected, uncertain costs of complying with future regulation of carbon dioxide emissions, possible high costs of complying with regulation of coal combustion residuals, and possible costs of meeting other environmental regulations such as regulations pertaining to cooling intake structures and ozone.

Q. If APS replaced Four Corners Units 1-3 entirely with purchases of energy and capacity from gas generation, would it face any risks?

A. Yes. Natural gas prices have historically been volatile and inaccurately predicted, so increased reliance on gas generation would expose APS to uncertain fuel costs. In addition, gas-fired power generation emits CO_2 (but at a rate per MWh that is less than half that of conventional coal-fired power plants), so APS would still face a risk of incurring costs to comply with potential carbon dioxide emission regulations.

Q. How can APS manage the risks you described?

A. The risks can be managed by focusing on a system-wide transition to a more sustainable energy economy. This transition process includes deployment of renewable resources, greater energy efficiency, and retirement of much of the remaining fleet of coal-fired power plants.

Q. What benefits would result from a transition to a clean energy economy?

A. A transition strategy provides the following benefits:

- **Reduced environmental impacts**. Continuing with coal-fired power generation will result in either continued emission of SO_2, NOx, CO_2, mercury, and other pollutants or increased costs of controlling pollutants. In contrast, most renewable energy and energy efficiency resources produce little or no air emissions and incur no costs in controlling air emissions. I briefly reviewed environmental impacts above.

- **Reduced exposure to cost uncertainties**. Coal-fired power plants face at least two types of cost uncertainty. First is uncertainty about the costs of the fuel. While delivered coal prices have been relatively stable (as compared to natural gas prices), they have increased over the past 15 years as indicated above. Second is uncertainty about the costs of complying with future environmental regulations, especially regulation of greenhouse gas emissions, but also potential regulation of cooling water intake structures, ozone, mercury, and coal combustion residuals.

- **Substitution of stably priced resources.** Most renewable energy resources do not involve acquisition of fuel (some biomass projects being the exception). Thus, they do not expose utilities or their customers to uncertain fuel price changes over time. Nearly all the costs of most renewable energy resources are capital costs, incurred up-front, so the costs are largely known at the time the project is built. Moreover, because renewable energy and energy efficiency have little or no air emissions, they are not subject to costs of complying with future air emission regulations, in contrast to coal-fired power plants. Additionally, wind energy, photovoltaics, geothermal resources, and some other renewable energy technologies are widely used so that their performance characteristics are well known and long term electrical output is generally predictable.

Thus, clean energy resources are stably priced while the future cost of electricity obtained from conventional coal-fired power plants is uncertain.

- **Technological advancement**. With technological change, economies of scale in manufacturing and installation, and learning-by-doing in manufacturing and installation, costs of clean energy resources decrease and performance improves.[9]

  At present, some renewable energy technologies – wind energy and geothermal energy -- are cost competitive with fossil-fuel power plants. The median contract price in 2009 for electricity obtained from 12 wind energy projects completed in 2008 or 2009 was about $50 per MWh, a very competitive price.[10] The median contract price in 2009 for electricity obtained from 4 geothermal projects completed in 2008 or 2009 was about $52 per MWh, also a competitive price.[11]

  PV costs have been falling in the last few years. Opportunities for technological improvement, learning-by-doing, and economies of scale occur as the volume of PV installations increases and as the size of utility-scale PV plants increases.

Q. What steps should APS take to continue the transition to cleaner resources?

A. To continue making the transition to cleaner resources, APS should take the following steps:

1. Plan to retire more coal-fired generating capacity within the next 10 years or so and replace that foregone capacity and energy with a portfolio of cleaner resources including large quantities of renewable energy. An example of a clean energy portfolio replacing Cholla Unit 1 (110 MW) is provided in Exhibit DB-5. The Commission's resource planning process can provide a venue for a more comprehensive examination of APS' resource mix and risk management strategies than the current docket. APS should include coal plant retirement options in its resource plans filed after a decision in this docket.
2. Evaluate a solar-coal hybrid at Four Corners 4 or 5 or other coal-fired power plant. The solar portion of the hybrid technology would supply some of the heat or steam necessary to generate electricity, displacing coal used at the power plant and reducing carbon dioxide and other emissions from the plant. The evaluation should be concluded

[9] For example, see Gregory Nemet, "Beyond the Learning Curve: Factors Influencing Cost Reductions in Photovoltaics," *Energy Policy* 34: 3218-3232 (2006).

[10] Prices calculated from purchased power data reported in utility 2009 FERC Form 1 filings. These wind projects are located in Wyoming, California, New Mexico, Colorado, Texas, Kansas, Iowa, Illinois, and South Dakota.

[11] Prices calculated from purchased power data reported in utility 2009 FERC Form 1 filings. These geothermal projects are located in Nevada and Idaho.

within one year of the Commission's decision in this docket and APS should then propose to the Commission, either in a separate filing or in the next scheduled resource plan filing, how it expects to proceed with a coal-solar hybrid facility.

Examples of solar hybrid facilities are described below:

a. There was a small (one MW) coal-solar hybrid demonstration project at Xcel Energy's coal-fired Cameo Generating Station in Colorado. Parabolic troughs concentrated sunlight to heat a transfer fluid that in turn preheated boiler water, thereby reducing the use of coal to produce steam in the boiler. Xcel found that addition of the solar component reduced coal consumption and associated air emissions. However, because it was a demonstration project, its performance was not as good as initially expected and Xcel indicates that current and future technological improvements may lower the cost and improve the performance of solar hybrid projects.[12]
b. A 75 MW solar hybrid project is located at FPL's existing Martin natural gas-fired combined cycle power plant in Florida. The solar portion of the plant uses parabolic troughs to concentrate sunlight and heat a transfer fluid that in turn produces steam for use in the combined cycle power plant. The solar steam supplements the steam produced in the power plant's heat recovery steam generators.[13]

Recommendations

Q. Should the Commission approve the retirement of Four Corners Units 1-3 and APS' acquisition of SCE's share of Four Corners Units 4 and 5?

A. Yes. APS' proposed plan to retire Four Corners Units 1-3 and to acquire SCE's share of Units 4 and 5 is in the public interest. There will be a dramatic reduction in NOx, SO_2, mercury, and CO_2 emissions that results in improved visibility, reduced health impacts, and reduced emissions of greenhouse gases. Acquisition of SCE's share of Units 4 and 5 and installation of NOx and other pollution control measures associated with APS' increased share of Units 4 and 5, while adding some risk, would be less costly than alternative resource mixes under a range of assumptions. In sum, retirement of Units 1-3 and APS' acquisition of SCE's share

[12] Xcel Energy, Final Report, Innovative Clean Technology, "The Colorado Integrated Solar Project," Colorado Public Utility Commission Docket No. 09A-015E, March 2, 2011.

[13] FPL, Florida Power and Light Company's Petition for Approval of Solar Energy Projects for Recovery through Environmental Cost Recovery Clause, Florida Public Service Commission Docket 08028-EI (May 16, 2008). Florida Public Service Commission Order No. PSC-08-0491-PAA-E1 (August 4, 2008). FPL Fact Sheet, "Martin Next Generation Solar Energy Center," http://www.fpl.com/environment/solar/martin.shtml.

Units 4 and 5 is a unique opportunity with reasonable costs that yields valuable health and environmental benefits for Arizona and the region.

Q. Should the Commission also order APS to proceed with additional actions to manage the risks of coal-fired power generation?

A. Yes. APS is exposed to uncertain and potentially high costs of continuing to rely on coal-fired power generation. Therefore, the Commission should also order APS to:

a. Undertake a comprehensive planning process to retire additional coal-fired power plants within the next 10 years or so and include coal plant retirement options in its resource plans to be filed after a decision in this docket. The options should include portfolios of clean energy resources, including large quantities of renewable energy, to replace the retired energy and capacity.

b. Evaluate a solar–coal hybrid at Four Corners 4 or 5 or other coal-fired power plant. The evaluation should be concluded within one year of the Commission's decision in this docket and APS should then propose to the Commission, either in a separate filing or in the next scheduled resource plan filing, how it plans to proceed with a coal-solar hybrid facility.

Q. Does this conclude your direct testimony?

A. Yes.

Exhibit DB-1: Qualifications of David Berry

Experience

Western Resource Advocates (Scottsdale, AZ), Chief of Policy Analysis and Senior Policy Advisor (2001 – present).
Navigant Consulting, Inc. (Phoenix, AZ), Senior Engagement Manager (1997-2001).
Arizona Corporation Commission (Phoenix, AZ), Chief Economist and Chief, Economics and Research (1985 – 1996).
Boston University Department of Urban Affairs and Planning, Lecturer (1981-1985).
Abt Associates, Inc. (Cambridge, MA), Senior Analyst (1979-1985).
University of Illinois Department of Urban and Regional Planning, Visiting Assistant Professor (1977-1979).
University of Pennsylvania Regional Science Department, Lecturer (1974 –1977).
Regional Science Research Institute (Philadelphia, PA), Research Associate (1972-1977).
U.S. Army (1969-1971).

Education

Ph.D.	Regional Science, University of Pennsylvania
MA	Regional Science, University of Pennsylvania
BA	Geography, Syracuse University

Referee for Peer-Reviewed Publications

International Regional Science Review, Annals of the Association of American Geographers, Ecological Economics, Energy Policy, Energy Economics, University of Pennsylvania Press.

Testimony and Public Comment Before:

Maine Land Use Regulation Commission, Arizona Corporation Commission, New Mexico Public Regulation Commission, Public Utilities Commission of Nevada.

Selected Publications

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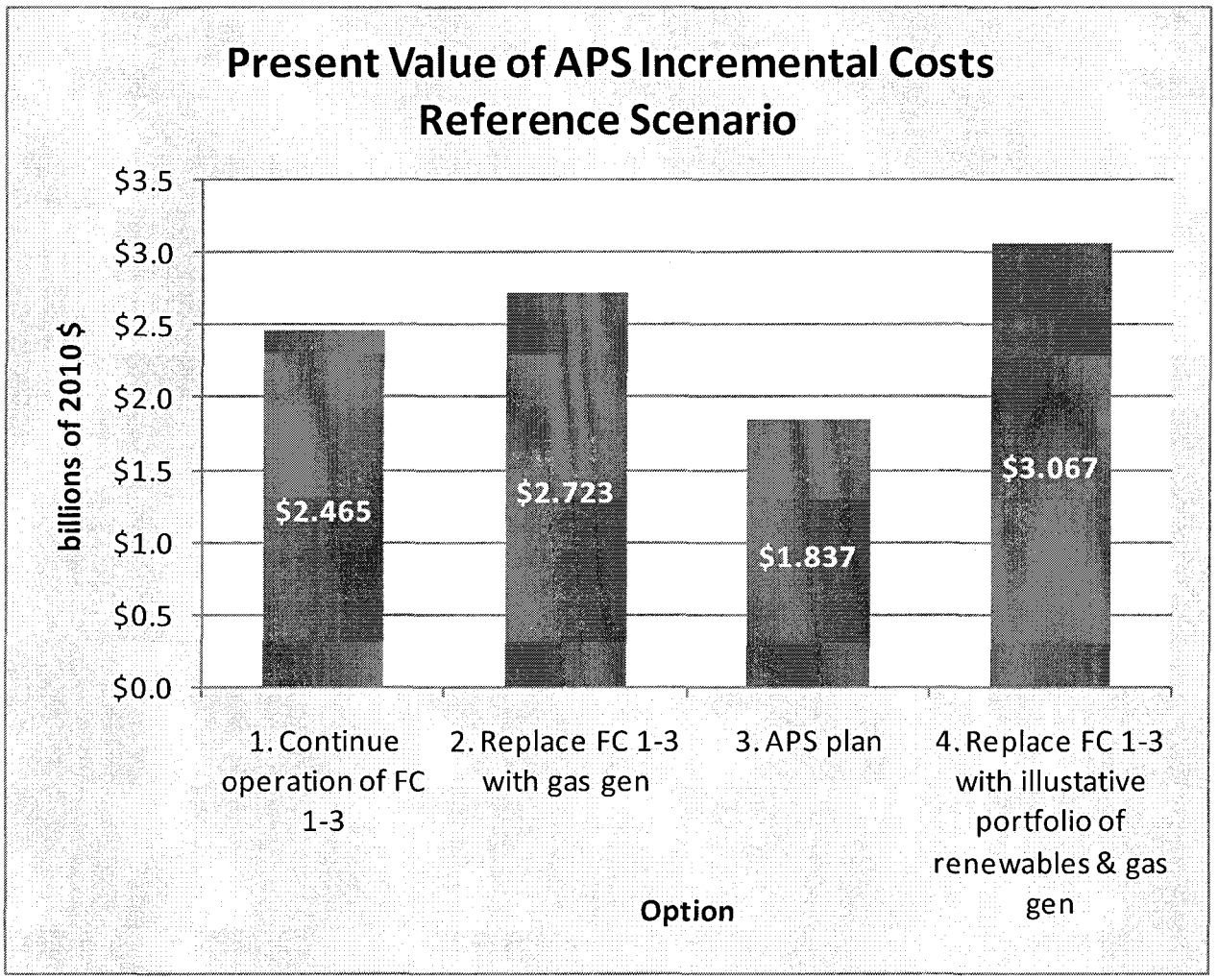
Exhibit DB-2: Regional Environmental Impact of APS Plan

replace SCE share of FC 4 & 5 w gas generation	MWh/yr	CO2 (metric tons per year)	SO2 (metric tons/year)	Nox (metric tons/year)	Hg (pounds per year)	water use (billion gallons/year)
baseline: 2009 operation of all 5 FC units (entire units 4 & 5, not just APS share)	15,722,965	14,928,872	10,195	39,330	573	8.15
retire FC 1-3	-4,338,179	-4,588,222	-2,497	-14,326	-351	-2.25
reduce APS gas generation	-1,126,518	-451,062	-2	-92	0	-0.20
replace SCE share of FC 4 & 5 w new gas generation	5,464,697	2,197,229	11	217	0	0.98
effect of BART FC 4&5				-20,003		
Result	15,722,965	12,086,817	7,707	5,126	222*	6.68
change from baseline	**0**	**-2,842,055**	**-2,488**	**-34,204**	**-351**	**-1.47**
% change from baseline	**0%**	**-19%**	**-24%**	**-87%**	**-61%**	**-18%**

replace SCE share of FC 4 & 5 w PV, geothermal, wind	MWh/yr	CO2 (metric tons per year)	SO2 (metric tons/year)	Nox (metric tons/year)	Hg (pounds per year)	water use (billion gallons/year)
baseline: 2009 operation of all 5 FC units (entire units 4 & 5, not just APS share)	15,722,965	14,928,872	10,195	39,330	573	8.15
retire FC 1-3	-4,338,179	-4,588,222	-2,497	-14,326	-351	-2.25
reduce APS gas generation	-1,126,518	-451,062	-2	-92	0	-0.20
replace SCE share of FC 4 & 5 w PV, geothermal, wind	5,464,697	0	0	0	0	0
effect of BART FC 4 & 5				-20,003		
Result	15,722,965	9,889,589	7,696	4,909	222*	5.70
change from baseline	**0**	**-5,039,284**	**-2,499**	**-34,421**	**-351**	**-2.45**
% change from baseline	**0%**	**-34%**	**-25%**	**-88%**	**-61%**	**-30%**

* If APS installs mercury emission controls on Units 4 & 5, mercury emissions would be smaller.

Exhibit DB-3: Reference Scenario Cost Analysis



Summary of reference scenario.

The costs included in the analyses are the incremental costs which APS would incur as a result of pursuing each option. **All costs are in 2010 dollars.** The present values of the streams of costs were calculated using a real discount rate of 7%. **No CO_2 emission regulations are assumed to apply in the reference case because of federal inaction.** Changes in some of the assumptions are described in conjunction with sensitivity analyses presented in the testimony above.

- For the option in which operation of Units 1-3 continues through 2037 (Option 1):[14]
  - APS would not acquire SCE's share of Units 4 and 5.
  - APS would incur costs for selective catalytic reduction and bag houses for NOx and PM control at Units 1-3.[15]

[14] It is assumed that dismantlement costs for APS' current share of Four Corners are included in depreciation rates. See testimony of Ronald White, June 2008, Docket No. E-0345A-08-0172, Statement G.

[15] Pollution control costs used in this analysis are from EPA's *Technical Support Document for the Proposed Rule: Source Specific Federal Implementation Plan for Implementing Best Available Retrofit Technology for Four Corners Power Plant: Navajo Nation*, in Docket No. EPA-OAR-2010-0683, and from APS' response to WRA data request 10.

- APS would invest in and operate mercury emission controls. Costs were estimated from studies prepared for the Department of Energy's National Energy Technology Laboratory and from APS' response to WRA data request #10.
- APS would incur baseline byproduct operating and maintenance (O&M) costs plus incremental coal combustion residual (CCR) costs under subtitle D of the Resource Conservation and Recovery Act. We used cost information from APS' response to WRA data request 21 and incremental CCR costs based on EPA's analysis of the proposed rule.[16]
- APS would make capital investments each year to keep the power plants operating properly.
- Coal costs $1.69 per MMBtu, escalating at a real rate of 0.56% per year (this cost reflects APS' 2009 coal cost for Units 1-3 escalating at the real rate for New Mexico coal prices over the period 1996-2010).
- Heat rates are those APS experienced in 2009.
- Operating and maintenance costs are from APS' January 2009 resource plan, escalated to 2010 dollars.

- For the option in which Four Corners Units 1-3 are retired at the end of 2016 and replaced with gas generation (Option 2) starting in 2017:
  - APS would make no further investment in Four Corners Units 1-3 and would not acquire SCE's share of Four Corners Units 4 and 5.
  - APS would purchase energy and capacity from combined cycle gas generation starting in 2017 to replace the foregone generation at Four Corners Units 1-3. The 2012 price of gas is from the Energy Information Administration *Short Term Energy Outlook*, February 2011, Table 2, adjusted to 2010 dollars. The natural gas price in subsequent years is from the Energy Information Administration *Annual Energy Outlook 2011*, adjusted to 2010 dollars. For years after 2035, the EIA forecast is extrapolated using the real price growth rate from 2025 to 2035. The average heat rate of the gas resources is assumed to be 7540 Btu/kWh. Gas generation capacity is assumed to cost $1150 per kW and a capital recovery factor of 10.61% is assumed.
  - There may be additional transmission costs to deliver the gas generation to the grid; these costs are not included in the analysis.
- For the APS plan (Option 3):
  - APS would take ownership of SCE's share of Units 4 and 5 in October 2012 and simultaneously retire Units 1-3.
  - APS would pay SCE $294 million for SCE's share of the units, plus net costs associated with the termination of the transmission agreement between APS and SCE, plus the value of SCE's capital expenditures in 2012 at Four Corners.[17]
  - APS would pay for selective catalytic reduction installed on the share of Units 4 and 5 obtained from SCE in 2018.[18]
  - APS would pay for control of emissions of mercury using activated carbon on the share of Units 4 and 5 acquired from SCE. Costs were estimated from studies prepared for the Department of Energy's National Energy Technology Laboratory.
  - APS would make no further investment in Four Corners Units 1-3.

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[16] In its response to WRA data request 21, APS provided lower costs for baseline coal combustion residual storage and handling costs for 2010 than the costs reported in EIA Form 923 for 2009 which include offsetting revenues from byproduct sales. Using the net costs from Form 923 does not substantively change the results.

[17] SCE testimony, p. 23.

[18] Pollution control costs used in this analysis are from EPA's *Technical Support Document for the Proposed Rule: Source Specific Federal Implementation Plan for Implementing Best Available Retrofit Technology for Four Corners Power Plant: Navajo Nation*, in Docket No. EPA-OAR-2010-0683.

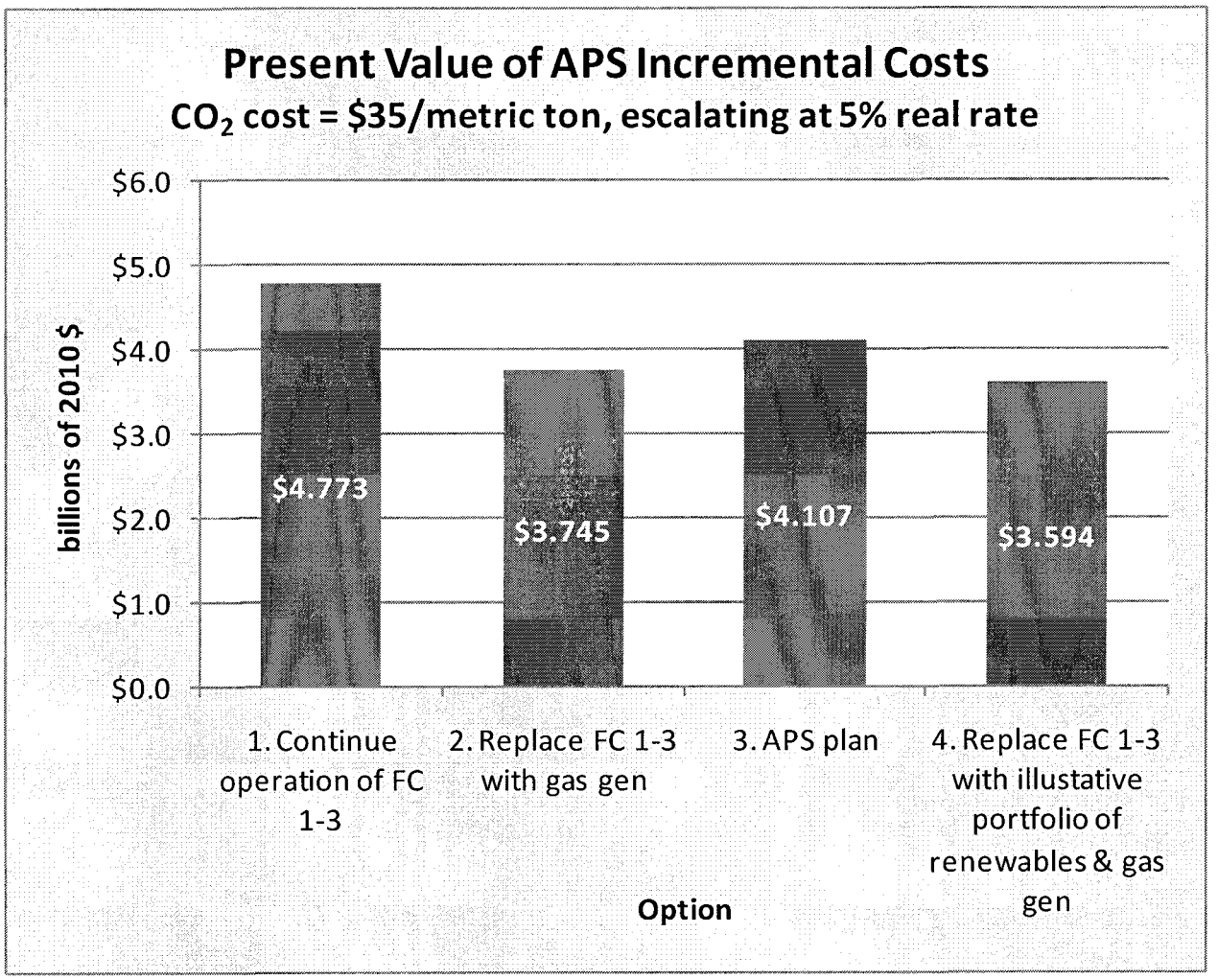
- APS would incur baseline byproduct O&M costs plus incremental CCR costs due to proposed regulations (assuming subtitle D of the Resource Conservation and Recovery Act) for the SCE share of Units 4&5. We used cost information from APS' response to WRA data request 21 and incremental CCR costs based on EPA's analysis of the proposed rule. (See note 16 above).
- APS would make capital investments each year to keep the share of Units 4 and 5 obtained from SCE operating properly.
- Operating and maintenance costs are from APS' January 2009 resource plan, escalated to 2010 dollars.
- APS would incur costs of decommissioning the 48% share of Units 4 &5 acquired from SCE, and would incur coal mine reclamation costs associated with the 48% share of Units 4 & 5 acquired from SCE. The costs of these activities were obtained from SCE's filings in California.
- Coal costs $1.70 per MMBtu, escalating at a real rate of 0.56% per year (this cost reflects APS' 2009 coal cost for Units 4 and 5 and the real coal price escalation rate in New Mexico over the period 1996-2010).
- Heat rates are those APS experienced in 2009.
- APS will avoid gas-fired generation of 1.1 million MWh per year because of the "surplus" of generation capacity it would acquire in Units 4 and 5 relative to its current capacity in Units 1-3. Natural gas is assumed to cost the same as in Option 2. The average heat rate of the avoided gas units is assumed to be 7540 Btu/kWh.

- For the illustrative clean energy portfolio of renewable energy and natural gas fired generation which replaces Four Corners Units 1-3 starting in 2016 (Option 4):
  - APS would make no further investment in Four Corners Units 1-3 and would not acquire SCE's share of Four Corners Units 4 and 5.
  - The illustrative portfolio assumes the resource mix shown in the table below:

resources	nameplate MW	CF	MWh/yr	capacity credit %	capacity credit MW	% of MWh
Photovoltaics	60	26%	136,656	60%	36	3.15%
Wind	400	35%	1,226,400	20%	80	28.27%
Geothermal	75	80%	525,600	100%	75	12.12%
concentrating solar power with thermal storage	100	40%	350,400	100%	100	8.08%
Other	0	0%	0	0%	0	0.00%
gas fired combined cycle	400	60%	2,099,123	100%	400	48.39%
Totals	**1,035**		**4,338,179**		**691**	**100.00%**
2009 APS FC 1-3 generation			**4,338,179**		**560**	

  - The resource mix in the table above provides a capacity credit (taking into account intermittency of photovoltaics and wind energy) that exceeds the capacity of Four Corners Units 1-3 and produces the same amount of energy as Four Corners Units 1-3.
  - The excess capacity credit has value because it displaces other capacity that APS requires.
  - Resource costs (in 2010 dollars) are as follows: photovoltaics =$135.35 per MWh, wind = $50.62, geothermal = $52.09, wind and photovoltaic integration costs = $4.00/MWh, concentrating solar power = $153.40, and gas generation cost is the same as in option 2.

Exhibit DB-4: Effect of CO_2 Regulation Compliance Cost



Assumptions are the same as in Exhibit DB-3, except that the cost of complying with CO_2 emission regulations is assumed to be $35 per metric ton, starting in 2015, escalating at a real rate of 5% per year.

Exhibit DB-5: Illustrative Clean Energy Portfolio to Replace Cholla 1

resources	nameplate MW	CF	MWh/yr	capacity credit %	capacity credit MW	% of MWh
Photovoltaics	25	26%	56,940	60%	15	7.61%
Wind	75	35%	229,950	20%	15	30.72%
Geothermal	20	80%	140,160	100%	20	18.73%
concentrating solar power with thermal storage	0	40%	0	100%	0	0.00%
other	0	0%	0	0%	0	0.00%
gas fired combined cycle(share)	80	46%	321,395	100%	80	42.94%
totals	**200**		**748,445**		**130**	**100.00%**
2009 Cholla Unit 1 generation			**748,445**		**110**	

Annual Air Emissions of Cholla Unit 1 and the Illustrative Portfolio

	NOx metric tons	SO2 metric tons	CO2 metric tons
illustrative portfolio	**26**	**13**	**131,867**
Cholla Unit 1 emissions in 2009	810	449	869,024